The PPPL Highlights for the week ending July 3, 2015, are as follows:

U.S. ITER FABRICATION (D. JOHNSON):

This year's ITER neutronics meeting was held at the ITER site over the week of June 30-July 3 and was attended by J. Klabacha and R. Feder. During this meeting, many topics were covered concerning the use of detailed neutronic models, updated neutronic analysis codes, and neutronic benchmarks. The Clite analysis model has had significant updates and is being finalized for distribution to the community. Material activation difficulties were discussed in great detail, and new material choices show great promise to help reduce the nuclear dose rate within the interspace and portcell regions. There has also been progress in the neutronics activities on JET in view of DT operations in support of ITER along with working towards a shutdown dose rate benchmark experiment at JET after the DD operations.

A. Basile, Y. Zahi and R. Feder attended ITER DSM Workshop #2 and presented the latest designs for US ITER EQ09 DSMs. The forum included discussion of the critical integration issue of PP weight vs, neutron/gamma shielding. Possible solutions discussed included refinement of stainless steel composition and weight-saving structural improvements. The other important topic discussed is the design of the mechanical support interface between the DSMs and the generic port plugs. An improved rail-and-pad design was presented by IO engineers that more effectively closes tolerance gaps and cushions the violent motions of the DSMs during plasma disruptions.

R. Feder attended the first of three Realistic Lifetime Schedule Baseline (RLSB) representing the U.S. ITER diagnostics projects. The RLSB meetings are running for three weeks in July with the goal of establishing an updated baseline for the ITER project.

This week, the UPP WAVs Mirror Cleaning Test Plan was released. Approval of this document authorizes TNO to begin building and commissioning the mirror cleaning prototype test setup. Samples of single-crystal Molybdenum will be cleaned using an Argon RF discharge in the UPP WAVs front end optics "bullnose" geometry. The tests will demonstrate the Argon sputtering effectiveness as well as the re-deposition of material to a second optical surface in close proximity.

PPPL received the Xenon test crystal from Eco Pulse this week. This X-ray diffraction crystal is customized for x-ray spectral emissions from Xenon. The ITER Core Imaging X-ray Spectrometer (CIXS) team ordered the special crystal to test the use of Xenon gas for ITER X-ray crystal spectroscopy measurements on the C-Mod machine at MIT. First, the test crystal will

be in the X-ray Laboratory at PPPL to determine that the crystal is performing as expected. C-Mod testing should start in September.

NSTX (M. ONO):

Good progress has occurred on commissioning and alignment of the Multi-Pulse Thompson Scattering (MPTS) diagnostic. The Nd:YAG laser beams were brought from the laser room into the test cell and up to the vacuum window on the laser input flight tube. Various optical elements in this part of the beam path were adjusted in preparation for passing the beam through the vacuum vessel.

The new support brackets for the Lithium Evaporators (LITERs) have been permanently welded to the upper umbrella structure. A review of the NSTX-U Experimental Machine Proposal (XMP) for the Lithium Granule Injector (LGI) revealed the need to prevent injection of granules in the absence of plasma. It was decided that the most straightforward interlock scheme would be to have the Plasma Control System (PCS) provide a permissive signal to the LGI control system.

The design of the stand and flight tube of the divertor SPRED diagnostic has been completed. A test fit of the receiver box for the Synthetic Aperture Microwave Imaging [SAMI] diagnostic was performed this week at Bay "I" mid-plane. A trial fit of one of the UV detector mounts at bay "E" mid-plane was performed. Welding of the re-entrant tube and window assembly of the Divertor Tangential Imaging diagnostic is in progress.

Recovery from an external arc fault at the Ohmic Heating (OH) coil terminals continued this past week. The OH compression ring assembly and new cooling tube supports were installed yesterday and electrical engineering inspections have been completed. Final inner divertor cooling tube installations and hydrostatic tests are being performed before the start of TF flex bus re-installations. A new procedure for the in-situ verification of high current bolted joint has been reviewed/approved, and will be conducted as sections of the TF bus connections are made. The OH coaxial connection assembly is ready for installation and in-situ epoxy potting. Final dummy load tests of the OH Rectifiers were completed this week, including test shots to exercise recent updates to the Power Supply Real Time Control (PSRTC) system. This completes all testing of the rectifiers for the NSTX-U coil systems. The Switching Power Amplifiers (SPA's) used to power the Resistive Wall Mode (RWM) coils will be tested in mid-July. A Conceptual Design Review for the future installation of High Z tiles at the outboard divertor was held this week.

ITER & TOKAMAKS (R. HAWRYLUK):

DIII-D (R. Nazikian):

B. Grierson and S. Haskey have been performing numerical simulations for the recently upgraded DIII-D pedestal main-ion CER system using the FIDASIM code. The FIDASIM model includes the accurate plasma geometry, all relevant atomic processes, and CER chord sight lines geometry. This allows the main ion D-alpha spectra to be forward modeled using plasma profiles from reference shots, or ideal synthetic profiles. A study of the diagnostic's expected

performance, as well as observations from DIII-D discharges with a range of density and ion temperature will form the basis for the validation of the pedestal main-ion CER system.

A. Nagy led the completion of the first neutral beam control system (NBLCS8). The assembly of the second system (NBLCS5) has commenced. All components for the second system are now in-house. W. Brown is being assisted by Madeline Vorenkamp (PPPL summer intern) for laying out the rack components. This unit is the second in a series of three control systems scheduled to be completed in the next two years.

Madeline Vorenkamp has completed her analysis of the new LGI dropper monitor, which detects dropped Lithium granules using an LED and photodetector. Three glass bead sizes were dropped and three distinct amplitude categories were found correlated to the granule size. The pulse width of the voltage appeared to be related to multiple granules being dropped. This testing needs to be run again with a fast camera to establish the relationship between the pulse width and the number of granules dropped simultaneously. During operations the voltage trace acquisition will be analyzed using Matlab to count the number of granules dropped including their size. An ablation detector will count the number of granules making it into the plasma, providing an injection efficiency.

C-Mod (E. Edlund):

An IR camera, on loan from PPPL, has been installed at MIT on Alcator C-Mod. The camera is mounted at the H-port side flange and looks down toward the inner divertor. Preliminary analysis of the data from MP 764 (Ian Fuast, June 26) shows a modulation of both the intensity and the position of the inner strike point corresponding to modulation of the LH power. These measurements will be used to constrain the LH power loss in the SOL.

International (R. Hawryluk):

R. Hawryluk gave a presentation on behalf of the Ad Hoc Group to the EUROfusion General Assembly on their assessment of the scientific and technical readiness of JET for their upcoming DT campaign.

ADVANCED PROJECTS (H. NEILSON):

S. Lazerson presented progress on equilibrium reconstruction and divertor modeling in stellarators at a workshop organized by the Wendelstein 7-X (W7-X) team at Germany's Max Planck Institute for Plasma Physics (IPP). The capabilities of STELLOPT to do 3D equilibrium reconstruction on W7-X were demonstrated through a 'mock' reconstruction using noisy modeled data. In this demonstration, a 2% beta standard configuration equilibrium was reconstructed using magnetics, Thomson scattering, and interferrometric diagnostics. Interfaces between the IPP CoDAc system and STELLOPT were also demonstrated. A benchmarking activity between V3FIT and STELLOPT, which would coincide with a site visit by M. Cianciosa (ORNL) to IPP, was proposed. During a second session, Lazerson presented ongoing work developing a new interface between VMEC and the EMC3/EIRENE edge modeling code. This work attempts to treat the transition between the VMEC equilibrium and the outside world through a flux-like grid scheme, which avoid numerical difficulties present when trying to resolve the VMEC

edge/vacuum transition region. This work emerged from a collaborative effort between groups at PPPL, Auburn University, and the University of Wisconsin.

THEORY (A. BHATTACHARJEE):

Several Theory Department members attended the town hall meeting of Frontiers of Plasma Science Workshops in Bethesda, Maryland. The workshops are sponsored by the DOE Office of Fusion Energy Sciences to identify the grand scientific challenges in plasma science. Invited talks given by PPPL staff were: W. Fox on “Opportunities using High Energy Density Laser Facilities for Basic Plasma Physics and Plasma Astrophysics", H. Ji on “Major Scientific Challenges and Opportunities in Plasma Astrophysics”, F. Ebrahimi on "Using large-scale magnetic fusion experiments to explore fundamental reconnection physics during helicity injection", and E. Gilson on “Nonneutral Plasmas and the Physics of Intense Charged Particle Beams”.

On July 2, R. Hager presented a theory seminar on non-local bootstrap current physics in an H mode pedestal plasma. We utilize the global, gyrokinetic neoclassical total-f particle code XGCa to establish better understanding of the physics of the bootstrap current in the H-mode edge pedestal and to develop a novel analytical formula that provides accurate prediction. To compare solutions in the local limit, we also used the local neoclassical code NEO [Belli et al., PPCF 54, 015015 (2012)]. In the first step, we performed a cross verification of XGCa, XGC0, and NEO in the local regime, which helped to identify and fix an inaccuracy in XGC0’s linear collision operator. XGCa uses a nonlinear Fokker-Planck-Landau operator. With this correction XGCa, XGC0, and NEO show excellent agreement in the local regime, where NEO’s perturbative formalism is valid. Differences to the Sauter formula [Phys. Plasmas 6, 2834 (1999)] are found even in the local regime for electron collisionality corresponding to the plateau and collisional regimes. These deviations of the Sauter model from XGCa and NEO are due to the collisional suppression of the passing particle contribution to the bootstrap current. When the pedestal width becomes comparable to the ion orbit width, local neoclassical theory breaks down and differences between XGCa and NEO can be observed. But as long as ions are collisional, these differences are found to be surprisingly small. However, a separate comparison of the ion and electron contributions to the bootstrap current still reveals the breakdown of the local treatment as ions and electrons experience quite different orbit averaged electric fields. With increasing pedestal top temperature (decreasing ion collisionality) to a practical level, non-local effects lead to more pronounced differences between XGCa and NEO, with the non-local bootstrap current being smaller than the local result. Qualitative similarities between XGCa and the PERFECT code [Landreman et al., PPCF 54, 115006 (2012)] are observed. The new understanding of edge pedestal physics together with the results from numerous XGCa simulations using geometries of various present-day tokamaks have been used to develop an improved bootstrap current formula which reproduces XGCa and NEO results much better than the Sauter formula, and which is much more accurate than the Koh et al. formula [Phys. Plasmas 19, 072505 (2012)].

PLASMA SCIENCE AND TECHNOLOGY (P. EFTHIMION):

Two undergraduate students, Tomo Hamada of University of Tokyo and Greg Wilcox of Washington University have started working on MRX to carry out summer internship research.

They will carry out plasma physics research for the first time with help of Jongsoo Yoo, a post-doctoral student and Jon Jara-Almonte, a senior graduate student at MRX. In addition, a graduate student of University of Tokyo, Kazu Kadowaki is carrying out a joint experimental study of asymmetric reconnection. Interesting data sets have been obtained.

This report is also available on the following web site:
http://www.pppl.gov/publication-type/weekly-highlights